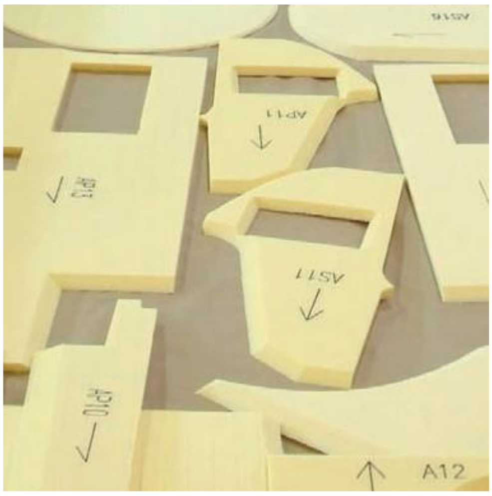

DELIVERING THE FUTURE OF COMPOSITE SOLUTIONS

CORE MATERIALS
PROCESSING GUIDE

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KEY POINTS SUMMARY

DESCRIPTION

Gurit can supply a large range of core products for composite applications, these include

- Gurit® Balsaflex™ – first quality end grain balsa in a range of formats
- Gurit® Corecell™ - SAN high performance structural foam
- Gurit® G-PET™ – re-cyclable thermoplastic core with good balance of properties versus cost
- Gurit® PVC & Gurit® PVC HT – cross-linked PVC good strength to weight ratio

STORAGE

All cores should be stored wrapped and dry
Gurit® Balsaflex™ in particular needs protecting from atmospheric moisture, keep in original wrapping until needed

CUTTING AND MACHINING

Health & Safety - protection should be worn to prevent dust/gas inhalation when cutting or machining any of Gurit's core range.
All cores can be worked with standard cutting and machine tools. Care needs to be exercised in preventing heat build-up which can soften or melt some core types.

CORE FORMAT

All Gurit core materials are available in a plain sheet format of varying thickness. Gurit cores are also available with a variety of finishing options to suit the processing method.
Perforations to allow resin and air bleed in vacuum bag/prepreg operations
Grooves to assist resin flow in infusion techniques
Cut and contour scrim formats to allow curvature conformability.

THERMOFORMING

It is possible to thermoform all Gurit cores except for Gurit® Balsaflex™. This removes the need to add multiple cuts to allow the core to conform to mould shape. This saves weight in resin uptake and preserves the core properties.
Specific temperatures are required for thermoforming each core type

RESIN COMPATABILITY

Gurit® Balsaflex™, Gurit® Corecell™ and Gurit® G-PET™ are all compatible with Epoxy, Polyester and Vinylester resin types.
Gurit® PVC is compatible with epoxy but *may* suffer styrene attack with some polyester and vinylester resins.

PROCESS COMPATABILITY

Wet laminating, vacuum bagging, infusion – all Gurit cores are compatible

CONTENTS

INTRODUCTION

This guide provides processing guidelines for the manufacture of structural sandwich panels using Gurit® Corecell™, Gurit® PVC, Gurit® G-PET™ and Gurit® Balsaflex™ core materials. Processing guidelines given are sufficient for the processing of the core material; further specific guidelines on the laminate processing can be found in other Gurit processing guides.
To ensure the fault free construction of large components it is recommended that representative test panels are always made. Further advice is available from Gurit Technical Support via your local customer services representative.

Type	Grade	Typical application
Gurit® Corecell™ SAN (styrene acrylonitrile)	T400 – T800	¬ Industrial grade structural foam ¬ Compatible with prepreg processing ¬ Superior strength & stiffness:weight ratio ¬ Cost-effective
	A400 – A800	¬ Ultra tough foam suitable for slamming applications
	M60 – M200	¬ High performance foam, ideal for marine applications High shear strength and low density Compatible with prepreg processing High elongation for toughness
Gurit® PVC (polyvinyl chloride)	PVC 40 - 250	¬ All-purpose foam ¬ Suitable for all sandwich applications ¬ Superior strength & stiffness:weight ratio ¬ Outstanding chemical resistance
	PVC HT 60 & 80	¬ High temperature processing up to 140°C
Gurit® G-PET™ (polyethylene terephthalate)	G-PET™ 80 – 200	¬ Recyclable ¬ Cost-effective ¬ Excellent mechanical properties
	G-PET™ 80 – 200 LITE	¬ Optional surface treatment to reduce resin uptake
Gurit® Balsaflex™	Balsaflex™ 100 - 220	¬ Classic wood core Available in typical densities and formats Very high mechanical properties Sustainably and responsibly sourced
	Balsaflex™ UVOTEC™	¬ Optional surface treatment to reduce resin uptake

Table 1 - Gurit structural core range

STORAGE

The core should not be exposed to extremes of temperature or humidity which cause moisture to be absorbed. Ideal storage conditions are between 10° and 30ºC and below 70%RH and kept in the original packaging until the time of use.

The main function of a core material is to provide a light and stiff sandwich panel, for which a good bond to the laminate skin is needed. To achieve this storing the foam such that it is clean and dust free is critical.

Direct exposure to sunlight should be avoided as in the short term this will discolour the foam and the in the long term may degrade the surface properties.

SPECIFIC GURIT® BALSAFLEX™ STORAGE GUIDANCE

As with most natural materials Balsa is susceptible to moisture absorption during storage, which can cause laminate adhesion and curing issues. To avoid moisture uptake in Gurit® Balsaflex™ core it should be stored with its packaging intact on the pallet until the last possible moment. A moisture meter may be used to confirm that the moisture level is below the recommended 12%.

There are three packaging options:

1. Boxes with sealed plastic bags inside allowing easy access to the panels while keeping the remainder protected
2. Boxes with plastic film inside allowing for faster access to panels
3. Shrink-wrapped plastic pallets which allow the fastest access to the panels with a reduction in packaging waste

As Gurit® Balsaflex™ only absorbs moisture in the direction of its fibres once the package is open it is only necessary to cover the faces of the sheets.

Boxes:

- Slit 3 sides of the top bag
- The top side of the bag can be used to cover the remaining balsa and reduce its exposure to the atmosphere

Shrink wrapped plastic pallets:

- Cover the panels with plastic once the pallet is opened

General points of care:

- Keep in original packaging until time of use.
- Reduce the humidity exposure time to a minimum by ensuring a dry working atmosphere.
- Never store balsa directly on a cement floor, always use pallets and protect the surfaces that can absorb moisture.
- When using VIP (Vacuum Infusion Process) leave the vacuum on the part for as long as possible before introducing the resin as during this time excess moisture is being removed from both the reinforcements and core.

HEALTH AND SAFETY

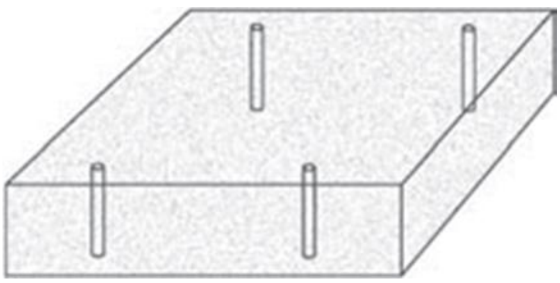
The main health and safety risk associated with core materials is due to ingestion of dust from machining. Exposure will occur at the time of machining at which point suitable extraction is necessary and operator dust masks may need to be used. Ideally all dust will have been removed during the cutting operation, but further exposure could happen during subsequent handling operations such as lay-up.
It is advisable to wear gloves during handling to avoid skin damage due to the mildly abrasive nature of the foam cores. Refer to MSDS available on the Gurit website.

CORE FORMATS

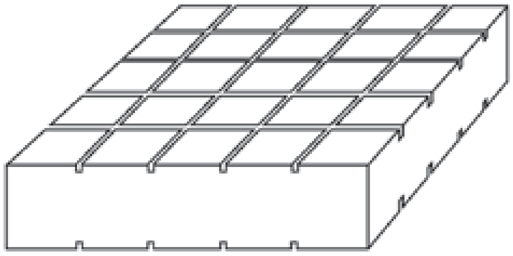
All Gurit core materials are available in a plain sheet format of varying thickness. Gurit cores are also available with a variety of finishing options such as perforations, grooving and slitting and scrim backed. All these add additional functions to the core such as conformability, laminate air removal and improved resin infusion.

CUTS FOR AIR REMOVAL AND RESIN DISTRIBUTION

PH – PLAIN / BLEEDER HOLE PERFORATED CORE - In general the quality of the final component is maximised by removing air from within the laminate. Regular bleeder hole perforations to the core allows air to be removed more effectively from within the laminate. The standard hole spacing is 50mm with a 2mm full depth hole.



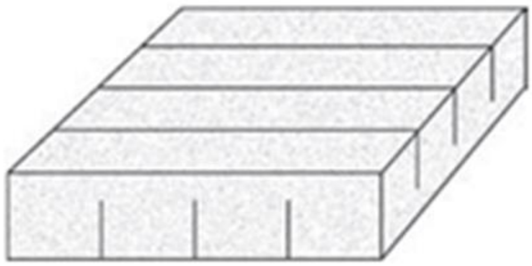
VIC CUT – VACUUM INFUSION CORE – Perforated core can also aid the flow of resin during vacuum infusion; ensuring that the occurrence of 'dry spots' on the tool side of the laminate are minimised. Adding a grooved surface to the core then add further functionality by forming resin flow channels which can remove the need for a separate infusion medium.



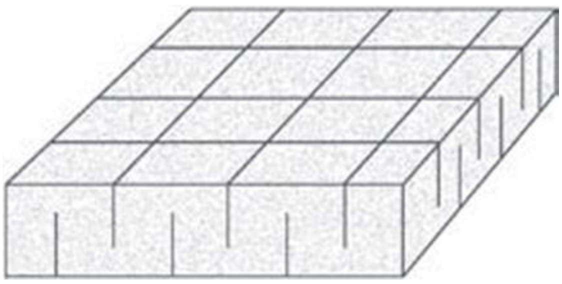
CUTS FOR CONFORMABILITY

Composite structures are typically not flat so core materials need to be shaped or have sufficient conformability to match the part shape. This can be achieved by thermo-forming, which is dealt with in another section, or slitting the core to give flexibility. Not only do the slits provide conformability, but when opened will also aid air removal under vacuum and provide a resin distribution path for infusion.

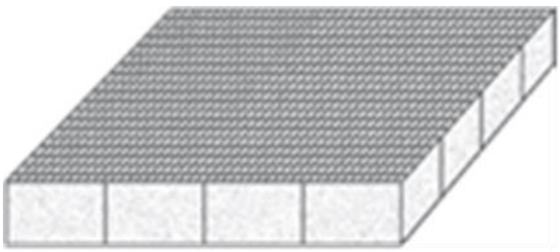
SINGLE CUT - Single Cut foam features a slit to 5mm from full thickness at a 25mm pitch. The slit allows the sheet to conform in one direction, whilst the 5mm remaining at the bottom of the cut maintains the foam in the sheet format. The slit is made with a knife so the width of the opening is minimal to reduce the resin uptake in vacuum infusion.
Additional slits can be provided on the other surface in the other direction which form intersections, removing the need for through thickness bleeder holes.



DOUBLE CUT - Double Cut which features slits in both directions on both faces to provide conformability in both directions. The spacing is 50mm between slits, with a 25mm spacing between slits from either side. Whereas double cut will provide greater flexibility than single cut, the additional surface area of the cuts and any opened cuts will increase the resin uptake during vacuum infusion.



CONTOUR SCRIM - Maximum flexibility is achieved with Contour Scrim by slitting all the way through into 30mm squares and bonding onto a glass scrim on one face. All core materials in the range are available in this format.



THERMOFORMING

Thermoforming is the process of shaping a foam core by heating to soften, clamping in the desired shape and then cooling to set the shape. It is possible to thermoform all Gurit foam cores. As Gurit® G-PET™, Gurit® PVC and Gurit® Corecell™ are all thermoplastic in nature the softening point happens over a broad range of temperatures, recommended temperatures for each core type are given in Table 2. The advantage is a potential weight saving due to less resin uptake in grooves and elimination of possible print through of the core cutting pattern.

PROCESS STEPS:

1. **HEATING -** Heat the foam to the stated thermo-forming temperature as detailed in Table 2. Heating can be via hot air or heated mould tool. Regardless of heating method, all of the foam must be at the correct temperature – it is advisable to measure the temperature with a thermocouple inserted into the centre of the sheet. The heat up rate is a function of core density, thickness and oven air flow. It is preferable to heat the part in the tool to be used for shaping so that the hot foam does not need to be moved, however the foam can be heated in a separate oven and then moved to the moulding or forming jig, although allowance must be made for the foam cooling during transfer. Heating above the recommended temperature will excessively soften the foam and could cause local deformation at loading points during forming.
2. **FORMING -** When the foam has reached the correct temperature load can be applied to form the foam into the tool. Load can be applied means of weights, vacuum bag or closed mould compression, depending on the size, complexity and number of parts required. Once the correct shape has been achieved the foam can be cooled till stiff and the weight or straps removed.
3. **AFTER FORMING -** During heating some expansion or contraction of the foam can be expected. This may produce steps between adjacent core pieces or gaps between pieces. It may be necessary to abrade any steps away and fill gaps with slivers of foam or core bond adhesive.

Type	Grade	Recommended thermo-forming temperature (ºC)	Maximum thermo-forming temperature (ºC)
Gurit® Corecell™ SAN (styrene acrylonitrile)	Gurit® Corecell™ A	75	85
	Gurit® Corecell™ M	110	120
	Gurit® Corecell™ T	105	125
	Gurit® Corecell™ S	110	120
Gurit® PVC (polyvinyl chloride)	PVC	120	135
	PVC HT	140	155
Gurit® G-PET™	G-PET™ & G-PET™$_{LITE}$	100	150 – see note below

Table 2 - Thermo-forming temperatures

THERMO-FORMING GURIT® G-PET™ – Gurit® G-PET™ sheets are made of blocks of extruded PET assembled on end and bonded together in a brick work pattern in order to give optimum through thickness mechanical properties. In the long direction the blocks are thermally welded so the performance of this joint is the same as the foam itself. However, in the short direction the blocks are bonded with a hot-melt glue which will soften at 110°C. To avoid opening these joints the thermoforming temperature should be kept below 110°C, although at this temperature forming may be slow. Opening the joint is often acceptable as is no different to a slit or groove in a single or double cut sheet format.

THERMO-FORMING BONDED SHEETS – When thick cores are required it may be necessary to use a bonded core, comprising of two sheets bonded together with an epoxy adhesive. Thermoforming of this format core is not recommended as any differential in the expansion or contraction of the individual sheets will cause distortion of the sheet.

THERMOFORMING FOR LARGE STRUCTURES

When thermoforming core for a large structure it is often not practical to shape sheets individually. The core is cut to size and roughly placed and held in position with weights or straps. Heat is then applied through either oven heating or using a heated mould, either way the entire thickness of the foam should reach the required temperature before applying load. It may be necessary if using a heated tool to use insulation blankets. Load can be applied with weight straps or a vacuum bag.
Often the core can only be placed roughly in the correct position and can only be fully placed once it has been heated sufficiently to allow it to conform to the required shape. For some shapes, multiple processes may be required to achieve a suitable fit.

Error! Reference source not found. shows core being thermoformed over a plug for a yacht hull. In this ase, the core has been bent as much as possible and attached to the plug using tie-down ropes (visible as white lines). The entire plug was then placed under a vacuum bag and the temperature was raised to the thermoforming level. As the core softened, the vacuum level was raised. Once the core was fully softened, the strings become redundant and the vacuum applied even pressure holding the core to the surface of the plug until it had cooled.

Thermoforming into a female mould is also possible. During the heat up the core will tend to sag under its own weight, but will eventually need weight added to achieve full form. The weights should be added gradually to avoid locally damaging the foam. A vacuum bag can also be used to draw the foam into the mould.

Figure 1 - Thermo-forming core over a male moulded yacht hull

SANDWICH CONSTRUCTION

Specific guidance for sandwich construction using wet laminating vacuum infusion and prepreg / SPRINT™ manufacturing methods are given below.

Regardless of the construction method, a sandwich panel comprising of a core material with a laminate skin on either side can be constructed and cured in one step. However, due to part geometry it may be necessary to laminate and cure the first skin, bond the core to the laminate in a 2nd operation and then compete the sandwich with the final skin in a 3rd operation.

WET LAMINATING AND INFUSION

RESIN COMPATABILITY

Good quality sandwich panels can be achieved with all cores types using common resins. Gurit® PVC foam can be degraded by the styrene in some polyester and vinylester resins. As epoxy resins do not contain styrene or other solvents there is no compatibility issue with Gurit® PVC. Compatibility issues between polyester / vinylester resins and Gurit® PVC core will tend to be more severe when infusing as these resins contain more styrene. Furthermore, any grooving or cutting introduced into the core to aid conformability or resin flow during infusion will increase the core surface area and thus increase the chance of core degradation. The incidence of Gurit® PVC degradation can be reduced by reducing the gel time of the infusion resin by increasing the temperature or increasing accelerator loading.

Resin System	Gurit® Corecell™	Gurit® Balsaflex™	Gurit® G-PET™	Gurit® PVC
Epoxy	Compatible	Compatible	Compatible	Compatible
Polyester	Compatible	Compatible	Compatible	Potential styrene incompatibility
Vinylester	Compatible	Compatible	Compatible	Potential styrene incompatibility

Table 3 - Laminating and infusion resin compatibility

CHECKING FOR GURIT® PVC AND POLYESTER / VINYLESTER COMPATIBILITY

There a number of checks that can be undertaken to determine whether the Gurit® PVC core will be degraded by the chosen resin system.

IMMERSION IN RESIN - Immerse the foam in accelerated resin for the expected gel time. Swelling, the most likely characteristic of degradation will be readily apparent.

MANUFACTURE OF REPRESENTATIVE TEST PANEL - Manufacture a representative test panel using the same materials and under the same conditions as intended for the final component. Any incompatibility between the Gurit® PVC and resin will be apparent from the following:

- Swelling of the foam
- Reduced adhesion between the foam core. This can be assessed by a hand pull-off test to check that failure has occurred within the core or ideally by measuring the pull-off force.
- Increase in gel time of the resin compared to a monolithic laminate.

CORE BONDING

If producing the laminate in several stages it will be necessary to bond the core to the cured first skin. A peel-ply should be applied to the laminate which should be removed just before application of the core. Good contact and adhesion can be achieved between the laminate and core by using Spabond 368 core bonding adhesive. The core material will need to be conformed to the mould shape using either weights or a vacuum bag. This can also be used to fill open grooves in the core.

RESIN UPTAKE WHEN WET LAMINATING

All core materials are porous so the level of resin uptake must be taking into consideration. Lower density cores with a larger cell structure will absorb more resin, as will cut patterns with open structure. To reduce the resin uptake when wet laminating it is common practice to prime the surface before laminating begins. The priming resin will be of the same type as used for the laminate, but with the addition of 4% silica to thicken the resin to reduce resin uptake. Once applied the primer layer may be left to tack-off before commencing the lamination. Typically 100-300g/m^2 is applied.

RESIN UPTAKE WHEN INFUSING

Taking account of the resin uptake of a core is more critical when using infusion than wet lamination or prepreg as the amount of resin used cannot be controlled. Indicative resin uptakes for different core materials are given in the table below. Panel Resin Uptake is the mass per m^2 of resin absorbed during infusion into both sides of a piece of foam. All values given are for plain format core only. Cut, grooved or perforated cores have higher resin uptake due to the open volume of the cuts. The function of the cut or groove is to allow the sheet to conform to the mould shape, so the resin uptake of these finishing options is not given as it is mostly depends on the amount to which the cuts and grooves are opened or closed.

The resin uptake of plain foam cores is independent of panel thickness for foam cores as resin is only absorbed into the open cells on the surface. For untreated foam core the resin uptake increases with reducing density due to the relative increase in cell size. The particular cell size of Gurit® G-PET™ results in relatively high resin uptake. However, Gurit® G-PET™$_{LITE}$ has a thermally sealed surface which significantly reduces resin uptake whilst maintaining peel strength.

Type	Core	Resin uptake kg/m2)
Gurit® Corecell™ SAN	T300	0.94
	T400	0.56
	T500	0.46
	A500	0.49
	M60	0.84
	M80	0.71
	M100	0.61
	M130	0.55
	M200	0.49
Gurit® PVC	PVC HT 80	0.62
	PVC 60	0.73
	PVC 100	0.56
	PVC 130	0.51
Gurit® G-PET™	G-PET 90	1.58
	G-PET 110	1.40
	G-PET 135	1.30
	G-PET 90 $_{LITE}$	0.70
	G-PET 110 $_{LITE}$	0.70
	G-PET 135 $_{LITE}$	0.70

Table 4 - Foam core Panel Resin Uptake

The mechanism of Gurit® Balsaflex™ resin uptake is by absorption into the tubular cell structure, therefore the resin uptake increases with core thickness, as can be seen in Table 5 below. Gurit® Balsaflex™ UVOTEC™ is a surface sealing coat applied to the balsa sheet at time of manufacture to fill the open tubular cell structure and reduce final resin uptake in the laminate. The resin uptake of a Gurit® Balsaflex™ UVOTEC™ is independent of core thickness.

<table>
<tr><th>Core</th><th>Thickness (mm)</th><th>Resin uptake (kg/m2)</th><th>Resin type</th></tr>
<tr><td rowspan="4">Gurit® Balsaflex™ 150</td><td>12.5</td><td>1.66</td><td rowspan="4">Epoxy</td></tr>
<tr><td>20.0</td><td>2.39</td></tr>
<tr><td>25.4</td><td>2.66</td></tr>
<tr><td>44.3</td><td>3.61</td></tr>
<tr><td rowspan="3">Gurit® Balsaflex™ 150 UVOTEC™</td><td>20.0</td><td>1.50</td><td>Epoxy</td></tr>
<tr><td>20.0</td><td>1.45</td><td>Polyester</td></tr>
<tr><td>20.0</td><td>1.45</td><td>Vinylester</td></tr>
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Table 5 – Balsa infusion Panel Resin Uptake

INFUSION DETAILS

There are numerous strategies to follow for infusion, the choice of which depends upon part geometry, size and laminate construction. The choice of core format is generally dependent on curvature, with higher curvatures requiring contour scrim product whereas lower curvatures can be handled with single or double cut and flat sheets with infusion cut. Any of these approaches will provide resin distribution channels within the foam core which may be sufficient for the component being produced, or additional specific resin channels or sacrificial flow mediums may need to be included.

Gaps at core joints between core sheets should be minimized. During the infusion gaps as these can act as resin distribution channels moving resin ahead of the intended flow front and locking-off areas of fabric causing dry spots. Large gaps will be filled with resin which may reach a high temperature during cure due to exotherm.

PREPREG/SPRINT™

RESIN COMPATABILITY

There are no chemical compatibility issues between Epoxy and Phenolic prepreg and any of the core types discussed.

	Gurit® Corecell™	Gurit® Balsaflex™	Gurit® G-PET™	Gurit® PVC
Epoxy	Compatible	Compatible	Compatible	Potential issues
Phenolic	Compatible	Compatible	Compatible	Compatible

Table 6 - Prepreg / SPRINT™ resin compatibility

OUTGASSING / CURE INHIBITION

Outgassing is the phenomenon of the evolution of gas from the foam due to the action of heat and vacuum during the laminate cure. In extreme circumstances the gas can cause the laminate skin to be forced off the core. Outgassing is generally only an issue with higher temperature prepreg processing as the tendency to outgas increases with temperature. The degree of outgassing increases with increasing core thickness and also increasing laminate thickness as the gas can less easily escape.
Cure inhibition of the laminate skins occurs when certain gases within the core act to slow the cure of the matrix resin. A partially cured laminate will have a lower T_g and reduced mechanical properties, but may be most easily recognised by a sugary appearance when peeled from the core.

GURIT® CORECELL™ AND GURIT® G-PET™ – Both foam types are tolerant to outgassing and cure inhibition during prepreg / SPRINT™ cures up to 120°C. There is no need to thermally treat the core before use. Higher cure temperatures of up to 140°C are possible, but a degree of expansion or contraction may occur.

GURIT® PVC AND GURIT® PVC HT – The infusion grade of Gurit® PVC is not suitable for use with prepreg / SPRINT™ as the temperature tolerance is not sufficient to withstand the required cured temperatures. Gurit® PVC HT requires a thermal treatment of 7 days at 40°C before use to avoid outgassing, inhibition of laminate skin cure and excessive expansion / shrinkage during the cure. The thermal treatment acts to reduce the amount of gas in the surface of the foam piece, so any thermal treatment must be undertaken after cutting. Cure temperatures of up to 120°C are possible, but should be verified with representative test panels.

USE OF GURIT® BALSAFLEX™ WITH PREPREG / SPRINT™

Gurit® Balsaflex™ is not typically used with prepreg, but processing is possible and high performance laminates can be achieved. The main issue is around the moisture in the wood 'boiling' off under the temperature and vacuum and forcing the laminate skin off before cure is completed or the moisture preventing full cure of the laminate skin. To avoid this, the following should be adhered to:

- Pre-dry core so that the moisture content is below 8%
- Thermally pre-treat through the intended cure cycle prior to lamination
- Cure at the lowest temperature possible. Cure temperatures of 120ºC are possible, but using lower temperature cures are advisable.

CORE ADHESION

The adhesion between skin and laminate should be sufficient that in standard shear and peeling loading situations the strength of the interface between the core and laminate is greater than the strength of the foam. This can be verified by pulling a strip of laminate from the core: if a layer of foam remains on the laminate surface the failure has been within the foam and the adhesion is good. Whereas if the laminate is free from foam, and in extreme cases has a glossy appearance, then adhesion will be poor. Whilst this concern for core adhesion is more relevant to prepregs / SPRINT™ construction where resin quantities are more tailored and extra resin is not available such as in infusion, it also applies to wet lamination and infusion.

Sufficient resin should be available at the interface between the prepreg and core to sufficiently wet and fill the surface layers of open cells. Whilst the foam surfaces will absorb resin from the prepreg, the quantity taken is significantly less than with infusion due to the lower time that that a prepreg resin has a sufficiently low viscosity to soak the core. A typical amount of additional resin to allow is about 150g/m^2 on each side of the core. This can be achieved by either:

- Increasing the resin content of the prepreg / SPRINT™ layer adjacent to the core
- Applying a specific resin film layer between the core and laminate. Gurit's SA 80 is an toughened epoxy adhesive film ideal for this application

When using SPRINT™ it is advisable to either place the resin film if using single-sided SPRINT™ against the core, or use an adhesive film layer. Not only does this ensure a good bond is achieved, but also provides tack to the core during layup that would not be achieved with dry fabric against core.

MAXIMUM CURING CONDITIONS

Each core type has a maximum cure temperature above which the core may be degraded such that mechanical properties are reduced or shrinkage / expansion may result. Typical maximum temperatures for curing are given in Table 7 below.

Type	Core	Normal processing temperature limit (°C)
Gurit® Corecell™ SAN	A	Not recommended for prepreg processing
	T	120ºC for 1 hour
	M	120ºC for 1 hour
Gurit® PVC	PVC	Not recommended for prepreg processing
	PVC HT	120ºC for 1 hour
Gurit® G-PET™	G-PET	130ºC for 1 hour
	G-PET 90 LITE	130ºC for 1 hour
Gurit® Balsaflex™	Gurit® Balsaflex™	120ºC
	UVOTEC™	120ºC

Table 7 – Maximum curing conditions

***NOTICE**: All advice, instruction or recommendation is given in good faith but the Company only warrants that advice in writing is given with reasonable skill and care. No further duty or responsibility is accepted by the Company. All advice is given subject to the terms and conditions of sale (the Conditions) which are available on request from the Company or may be viewed at the Company's website: http://www.gurit.com/*

*The Company strongly recommends that Customers make test panels and conduct appropriate testing of any goods or materials supplied by the Company to ensure that they are suitable for the Customer's planned application. Such testing should include testing under conditions as close as possible to those to which the final component may be subjected. **The Company specifically excludes any warranty of fitness for purpose of the goods other than as set out in writing by the Company**. The Company reserves the right to change specifications without notice and Customers should satisfy themselves that information relied on by the Customer is that which is currently published by the Company on its website. Any queries may be addressed to the Technical Department*